Introduction to Physical Science

Solubility

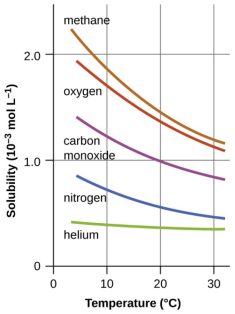
Presented by Robert Wagner

Solubility

- Solubility of a solute
  - Maximum concentration of solute in a specific solvent under specific conditions
- Saturated vs. unsaturated
  - Saturated - concentration of solute is equal to its solubility
  - Unsaturated - concentration of solute is less than the solubility
  - Supersaturated - concentration of solute exceeds the solubility

Solutions of Gases in Liquids

- Gas solubility typically decreases as temperature increases
- Example - increased water temperatures means decreases oxygen solubility
- Henry's Law:
  -
  - = solubility of gas
  - = partial pressure of gas



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Example

- At 20°C, the concentration of dissolved oxygen exposed to gaseous oxygen at a partial pressure of 101.3 kPa is $1.38x10^{-3}$ $molL^{-1}$. Use Henry's Law to determine the solubility when the partial pressure is 20.7kPa.

$$C_g = 1.38x10^{-3}molL^{-1}\ ;\ P_g = 101.3\ kPa$$

$$C_g = kP_g$$

$$k = \frac{C_g}{P_g} = \frac{1.38x10^{-3}molL^{-1}}{101.3\ kPa}$$

$$k = 1.36x10^{-5}molL^{-1}kPa^{-1}$$

$$C_g = kP_g = (1.36x10^{-5}molL^{-1}kPa^{-1})(20.7\ kPa)$$

$$C_g = 2.82x10^{-4}molL^{-1}$$

Example

- A certain species of freshwater trout requires a dissolved oxygen concentration of 7.5 mg/L. Could these fish thrive in a polluted stream (water temp = 30.0°C, partial pressure of oxygen = 0.17 atm)
  - Figure 11.8 shows that the solubility at this temperature is $1.2x10^{-3}$ mol/L

$$C_g = 1.2x10^{-3}molL^{-1}\ ;\ P_g = 0.17\ atm$$

$$C_g = kP_g$$

$$k = \frac{C_g}{P_g} = \frac{1.2x10^{-3}molL^{-1}}{1\ atm}$$

$$k = 1.2x10^{-3}molL^{-1}atm^{-1}$$

$$C_g = kP_g = (1.2x10^{-3}molL^{-1}atm^{-1})(0.17\ atm)$$

$$C_g = 2.0x10^{-4}molL^{-1}$$

$$C_g = (2.0x10^{-4}mol/L)(32.0g/mol)(1000mg/g) = 6.4mg/L$$

Solutions of Liquids in Liquids

- Miscible - liquids that can be mixed in any proportion with each other
  - Ex: Ethanol, sulfuric acid, ethylene glycol
- Immiscible - Liquids that do not mix significantly
  - Ex: Oil, gasoline, benzene
- Partially miscible - Liquids that partially mix together

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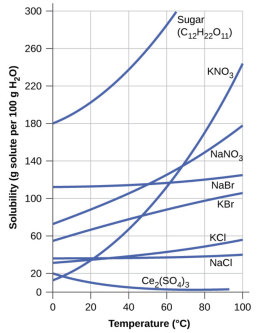
- Solubility generally increases with temperature
- Supersaturated solutions
  - Prepare at a higher temperature and then cool off
  - Remain stable until:
    - Seed crystal added
    - Mechanical agitation



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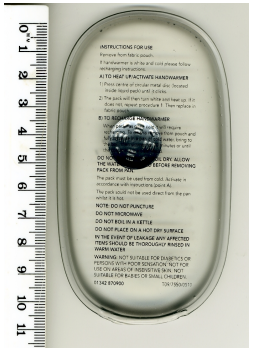

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Summary

- The solubility is the maximum amount of a solute that can be dissolved in a solution
- Henry's Law allows us to calculate the solubility of gases in liquids
- Liquids can be miscible, immiscible or partially miscible